UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

July 14, 2016

PC Code: 113501, 113502
DP Barcode: 433140

MEMORANDUM

Subject: **Metalaxyl/Mefenoxam:** Drinking Water Assessment in Support of Registration Review

From: He Zhong, Ph.D., Biologist
Environmental Risk Branch 1
Environmental Fate and Effects Division (7507P)

HE ZHONG Digitally signed by HE ZHONG
DN: c=US, o=U.S. Government, ou=USEPA, ou=Staff, cn=HE ZHONG, dnQualifier=0000051219
Date: 2016.07.14 13:54:42 -04'00'

Through: Sujatha Sankula, Ph.D. Branch Chief
Gregory Orrick, RAPL
Environmental Risk Branch 1
Environmental Fate and Effects Division (7507P)

SUJATHA SANKULA Digitally signed by SUJATHA SANKULA
DN: c=US, o=U.S. Government, ou=USEPA, ou=Staff, cn=SUJATHA SANKULA, dnQualifier=0000034075
Date: 2016.07.14 14:39:23 -04'00'

Gregory Orrick 2016.07.14 14:17:48 -04'00'

To: Leigh Rimmer, Chemical Review Manager
Kevin Costello, Branch Chief
Risk Management and Implementation Branch 2
Pesticide Re-evaluation Division (7508P)

Laura Nollen, Risk Assessor
Christine Olinger, Branch Chief
Risk Assessment Branch 3
Health Effects Division (7509P)

The Environmental Fate and Effects Division (EFED) has completed the drinking water assessment (DWA) for a systemic phenylamide fungicide, metalaxyl [(R,S) 2-[2,6-dimethylphenyl)-methoxyacetylamino]-propionic acid methyl ester] and mefenoxam [(R) 2-[2,6-dimethylphenyl)-methoxyacetylamino]-propionic acid methyl ester], in support of human health risk assessments of the Health Effect Division (HED) for Registration Review. Metalaxyl is a racemic mixture composed of approximately equal proportions of the *R*- and *S*-enantiomers, whereas mefenoxam is an enriched mixture comprised almost solely of the *R*-enantiomer, which has more fungicidal activity than the *S*-enantiomer. The applications rates for mefenoxam are about half of that for metalaxyl. The environmental fate data for both compounds are bridged in this assessment. The maximum estimated drinking water concentrations (EDWCs) of the residues of concern (ROC) are not expected to exceed **6,512 µg/L** for acute exposure and **4,413 µg/L** for chronic exposure from groundwater sources and not expected to exceed **444 µg/L** for

acute exposure and **248 µg/L** for chronic exposure from surface water sources (**Table 1**). These EDWCs supersede previous recommendations.

The above groundwater values provide an upper bound on potential exposure due to the incorporation of unextracted residues as the residues of concern (ROC). There is uncertainty in the availability of the unextracted residues because multiple extraction solvents with a range of dielectric constants were not used to extract residues from the soil. A substantial amount of the unextracted residues (up to 54%) were reported in several soil studies (MRIDs 00104494, 47886102 and 47886104). Therefore, the aerobic soil metabolism half-lives were recalculated with and without the inclusion of unextracted residues. Inclusion of the unextracted residues into the half-life calculations is a conservative approach. If the unextracted residues are demonstrated to not be ROCs, then EDWCs would not be expected to exceed **4,922 µg/L** for acute exposure and **3,485 µg/L** for chronic exposure (**Table 1**).

EFED has explored a different currently labeled application technique other than aerial spray to consider the impact on EDWCs. If metalaxyl is used as a soil drench at the maximum application rate of 10.4 lb/A, the maximum groundwater EDWCs are reduced from 6,512 to **3,760 µg/L** for acute exposure and from 4,413 to **3,443 µg/L** for chronic exposure. In addition, reduction of the application rate can also reduce the EDWCs. The maximum annual application rate for mefenoxam as an aerial spray at 6 lb/A, which is about half of that for metalaxyl, was modeled showing that the EDWCs are **3,179 µg/L** for acute exposure and **2,153 µg/L** for chronic exposure (**Table 1**).

Table 1. Estimated Drinking Water Concentrations (EDWCs) of Metalaxyl/Mefenoxam Residues of Concern (ROC) from Surface Water and Groundwater Sources [A]

Fungicides (water source)	Use Site (Application method, max single rate & interval)	Acute EDWC (µg/L)	Chronic EDWC (µg/L)
EDWCs of ROCs excluding unextracted residues (Scenario 1) Pesticide Water Calculator (PWC ver. 1.52)			
Metalaxyl (Surface Water)	FL Citrus (w12842.dvf) (Aerial spray at 4.1 lb ai/A, 3 apps & 3mo interval)	440	144
	MI Cherry (w14850.dvf) (Aerial spray at 4.1 lb ai/A, 3 apps & 3mo interval)	310	243
Metalaxyl (Groundwater)	NC Cotton, Met File (13722.dvf) (Aerial spray at 4.1 lb ai/A, 3 apps & 3mo interval)	**4,922**	**3,485**
	NC Cotton, Met File (13722.dvf) (Soil drench at 10.4 lb ai/A one application)	1,486	1,395
Mefenoxam (Groundwater)	NC Cotton, Met File (13722.dvf) (Aerial spray at 2 lb ai/A, 3 apps & 3mo interval)	2,402	1,701
EDWCs of ROCs including unextracted residues (Scenario 2) Pesticide Water Calculator (PWC ver. 1.52)			
Metalaxyl (Surface Water)	FL Citrus (w12842.dvf) (Aerial spray at 4.1 lb ai/A, 3 apps & 3mo interval)	**444**	147
	MI Cherry (w14850.dvf) (Aerial spray at 4.1 lb ai/A, 3 apps & 3mo interval)	318	**248**
Metalaxyl (Groundwater)	NC Cotton, Met File (13722.dvf) (Aerial spray at 4.1 lb ai/A, 3 apps & 3mo interval)	**6,512**	**4,413**
	NC Cotton, Met File (13722.dvf) (Soil drench at 10.4 lb ai/A one application)	**3,760**	**3,443**

Fungicides (water source)	Use Site (Application method, max single rate & interval)	Acute EDWC (µg/L)	Chronic EDWC (µg/L)
Mefenoxam (Groundwater)	NC Cotton, Met File (13722.dvf) (Aerial spray at 2 lb ai/A, 3 apps & 3mo interval)	**3,179**	**2,153**

[A] EFED recommends the maximum EDWC values in bold.

Table 1 lists the acute and chronic EDWCs from surface water and groundwater sources. The maximum EDWCs (**6,512 µg/L**, acute and **4,413 µg/L**, chronic) from groundwater sources are orders of magnitude higher than those (**444 µg/L**, acute and **248 µg/L**, chronic) from surface water sources. This is because the compounds do not hydrolyze. **A new hydrolysis study with an extended duration (preferably ≥120 days) may yield a hydrolysis half-life for the ROCs that may help refine the groundwater exposure modeling.**

The current EDWCs are greater than those recommended in the previous assessment, 108.9 µg/L (acute) and 36.7 µg/L (chronic) (USEPA 2007, DP324495; USEPA 2010a, DP376655) because of the following reasons:

1). Used the latest PRZM/VVWM graphical user interface, the pesticide water calculator (PWC ver. 1.52);

2). Recalculated half-lives of the ROCs using PestDF (ver. 3.1.2), which implements the NAFTA-harmonized kinetics guidance, based on the most recent data submitted by the registrant, including analysis of the impact of unextracted residues on aerobic soil metabolism half-lives;

3). Modeled the ROC soil mobility in groundwater using the Koc of CGA-62826, degradate of metalaxyl, (Koc = 39) rather than the Koc of metalaxyl (Koc = 409);

4). Used a percent cropped area (PCA) of 100% rather than 87% due to the non-agricultural uses (USEPA 2012c).

5). Used the default aerial spray drift model input of 13.5% rather than 5%, which is based on current guidance (USEPA 2013).

In addition, consistent with the previous drinking water assessments, a total toxic residue (TTR) approach was used to account for the parent compound and two major metabolites of concern, CGA-62826 (USEPA 2000, DP 269910) and CGA 119857 (only for the half-life calculation of the anaerobic aquatic metabolism) (USEPA 2010c, DP 371309).

The national water quality assessment water quality portal (NAWQA-WQP) reports that the maximum metalaxyl concentration was **46.4 µg/L** in New York surface water and **3.79 µg/L** in Washington groundwater below 12.5 feet. Maximum concentrations of metalaxyl in the groundwater monitoring analyses (up to 3.79 µg/L) are less than those from groundwater modeling (4,400-6,500 µg/L) for a variety of reasons, including the lack of targeted monitoring analyses, lack of analysis for degradates of concern, potentially less usage in practice than the modeled use patterns, and uncertainty in the environmental fate data used in modeling, including uncertainty in the stability of metalaxyl/mefenoxam to hydrolysis and uncertainty in the availability of the unextracted residues.

Previous Drinking Water Assessment

Three metalaxyl/mefenoxam DWAs were previously completed (USEPA 1993, DP197035; USEPA 2007, DP324495; USEPA 2010a, DP376655). The previous assessments were based on the TTR approach for the ROC and the Florida citrus model scenario. Previously recommended Estimated Drinking Water Concentrations (EDWCs) were 108.9 µg/L for the 1 in 10 year daily peak concentration, 36.7 µg/L for the 1 in 10 year annual concentration, and 25.9 µg/L for the 30 year annual average concentration from surface water sources and 1.72 µg/L from groundwater sources. In a registrant-sponsored prospective groundwater monitoring study, the maximum residue concentration was 3.0 µg/L (USEPA 2007, DP324495).

Mode of Action

Metalaxyl/mefenoxam is a systemic phenylamide fungicide used specifically to control oomycetes fungi. The mode of action is inhibition of RNA synthesis in affected fungi.

1. Use Characterization

Metalaxyl/mefenoxam is used on both agricultural and non-agricultural sites as a soil band, broadcast, chemigation, soil drench, or foliar spray treatment (using aerial or ground equipment). It is formulated as a dust, emulsifiable concentrate, flowable concentrate, liquid-ready to use, water dispersible granule, or wettable powder formulation for seed treatments. According to a screening level usage analysis (SLUA) of national agricultural pesticide usage data (2004 – 2013) by the Agency's Biological and Economic Analysis Division (BEAD) (USEPA 2015a), an annual average of 108,500 lb ai metalaxyl was applied to agricultural sites in the United States. Of this, about 65% of the total usage was soybean seed treatment (70,000 lb ai), and 10% was wheat seed treatment (10,000 lb ai) (USEPA 2015a). Since 1992, mefenoxam has been registered for similar use sites, replacing some of the usage of metalaxyl. An annual average of 309,000 lb ai mefenoxam was applied to agricultural sites in the United States. Of this, about 13% of the total usage was on potatoes and soybean seed treatment (40,000 lb ai each), 9.7% was on oranges, tobacco and tomatoes (30,000 lb ai each) and 2.9% was wheat seed treatment (9,000 lb ai) (USEPA 2015b).

The application rates for metalaxyl/mefenoxam on various crops were summarized by BEAD (**Appendix I, Tables A1** and **A2**). The applications rates for mefenoxam are about half of that for metalaxyl. The use and usage information, however, is incomplete. Application information for many registered uses is not specified (NS) in the tables, such as the maximum number of applications per year, the maximum annual application rate and the minimum retreatment interval. The Agency is assessing use patterns from the label with complete application information, assuming they are representative of use across the labels. To the extent that use exceeds these assumptions, the DWA may under-predict exposure. If the labels with incomplete application information are not made consistent with the labels with complete information, then further exposure assessment may be needed.

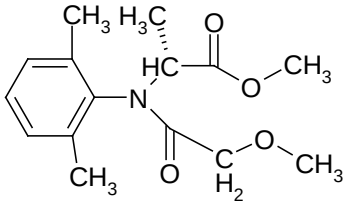
2. Environmental Fate and Transport

The environmental fate and transport data for metalaxyl and mefenoxam were bridged based on structural similarity (USEPA 2007, DP324495 and 2010b, D368463). The parent compound is stable to hydrolysis ($t_{1/2}$ > 200 days) in pH 5 and pH 7 buffer solution (MRID 00104493). It is also considered stable to photodegradation on soil surfaces (MRID 43883402) and it persists in aquatic environments ($t_{1/2}$ = 400 days) (MRID 41156001). The parent compound is moderately persistent in aerobic mineral soils with half-lives of 37.5 days (MRID 00104494), 85.8 and 65.5 days (MRID 43935301), 10.1 days (MRID 47886102) and 26.4 days (MRID 47886104). The major aerobic degradation product was found to be CGA-62826 (N-(2, 6-dimethylphenyl)-N-(methylacetyl-L-alanine)). A substantial amount of the unextracted residues (up to 54%) were reported in several soil studies (MRIDs 00104494, 47886102 and 47886104). Metalaxyl/mefenoxam was found to be moderately persistent (half-life of 29 days) under an anaerobic water-sediment environment, where it transformed into two major degradates, CGA-62826 (48%) and CGA 119857 (16%) at 385 days (MRID 42259801). It is also moderately persistent under aerobic aquatic environments (half-life range of 22 to 55 days; MRIDs 42259802 and 47886101), where it transforms to one major degradate, CGA-62826 (76% at 240 days).

Metalaxyl/mefenoxam is expected to be moderately mobile in soil and aquatic environments, with Freundlich adsorption coefficients (Kd) that range from 0.1 (Koc=20) in sand to 7.6 (Koc=570) (MRID 43875309). The degradate, CGA-62826, is expected to be very highly mobile in soil and aquatic environments (Mean Koc = 39, range = 31-45; MRID 47886103). Both parent and degradate CGA-62826 are readily leached in soil columns of sand textured soils with low organic matter and were detected in the leachate from aged soil column leaching studies (MRID 43935302). In addition, the parent compounds have a low volatilization potential from soil, with a vapor pressure of 2.2×10^{-6} mm Hg at 25ºC, and a low potential to bioconcentrate, with a whole-fish bioconcentration factor of <7x.

Under typical use conditions, metalaxyl/mefenoxam was found to be moderately persistent ($t_{1/2}$=27 - 56 days) in field dissipation studies (MRIDs 40985403, 40985404, 41765001, 41765002 and 41809301). In aquatic field dissipation studies, the compound had half-lives of 5 - 20 days in rice paddy water and 11 - 24 days in soil (MRIDs 42259803 and 42259804). The major degradation product, CGA-62826, was found in several field dissipation studies. These field results are consistent with the results of the laboratory studies. **Tables 2** and **3** list the environmental fate and transport properties for metalaxyl/mefenoxam and the major degradate CGA 62826, respectively. The degradates and their amounts formed in the submitted environmental fate studies are listed in **Appendix II**.

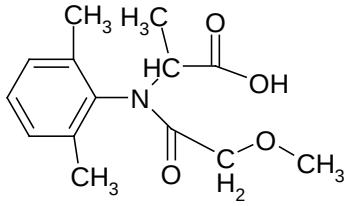
Table 2. Environmental Fate and Transport Properties for Metalaxyl/Mefenoxam

Parameter	Value	Reference
Physical/Chemical Parameters		
CAS Name	Methyl N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-D-alaninate	
CAS Number	70630-17-0	MRID 47886102
Molecular formula	$C_{15}H_{21}NO_4$	MRID 47886102
Molecular Weight	279.34 (g/mole)	MRID 47886102
Molecular Structure		EPI Suite (v4.11)
SMILES	COCC(=O)N(c1c(C)cccc1C)[C@H](C)C(=O)OC	
Vapor pressure (20°C)	$2.2E^{-6}$	MRID 00079041
Henry's Law constant (25°C)	$8.05E^{-10}$	EPI Suite (v4.11)
Water solubility (mg/L at 25ºC)	26,000	MRID 47886102
Log Kow	1.65	EPI Suite (v4.11)
Persistence in Water		
Hydrolysis half-life (at 50 °C, pH 5 & 7)	Stable (>200 days)	MRID 00104493
Aqueous photolysis half-life (25°C)	400 days	MRID 41156001
Aerobic aquatic metabolism half-life (25°C)	55.1 d (SFO^1) 47.5 d ($IORE^1$) and 22.4 d ($IORE^1$)	MRID 42259802 MRID 47886101
Anaerobic aquatic metabolism half-life (25°C)	29.2 d (SFO^1)	MRID 42259801
Persistence in Soil		
Soil photolysis half-life (25°C)	Stable	MRID 43883402
Aerobic soil metabolism half-life (20°C)	37.5 d (SFO^1) (clay loam)	MRID 00104494
	85.8 d (SFO^1) (sandy loam, mefenoxam)	MRID 43935301
	60.5 d (SFO^1) (sandy loam, metalaxyl)	
	10.1 d (SFO^1) (sandy clay loam)	MRID 47886102
	26.4 d (SFO^1) (sandy loam soil)	MRID 47886104
Mobility		
Freundlich organic carbon normalized soil-water partitioning coefficient (K_{FOC}) L/kg	Clay = 570, Sand = 20, Sandy Loam = 68 Loam = 86, Si CL Lo = 1299	MRID 43875309

Parameter		Value	Reference
Field Dissipation			
Terrestrial field dissipation half-life[2] (Detected leaching depth detection and time)	Unvegetated plot, -sandy loam soil	CA: 36 d (0-6” depth at day 0)	MRID 40985403
	Tomato plot, -sandy loam soil	CA: 27 d (0-6” depth at day 0)	MRID 40985404
	Bare plot, - loamy sand soil	CA: 56 d (36-48” depth at day 270)	MRID 41765001
	Vegetated and tobacco, -bare soil plot	NC: 38-39 d (24-36” depth at day 3 in vegetated plot) (36-48” depth at day 0 in tobacco plot)	MRID 41765002
	Citrus plot, -sandy loam soil	CA: 50 d (36-48” depth at day 14)	MRID 41809301
Aquatic field dissipation half-life[2] (Detected leaching depth detection and time)	Rice paddy, -Alamo clay	CA: 20 d paddy water and 24 d soil (3-6” depth at day 0)	MRID 42259803
	Rice paddy, -Falaya silt loam	CA: 5 d paddy water and 11 d soil (6-9” depth at day 7)	MRID 42259804
Fish bioconcentration factors (depuration rate) -catfish		<7x (whole); <15x (inedible); <1x (edible) (>50% depuration in 3 days)	MRID 100468 (acc # 238232)

[1] Kinetics models used to calculate half-lives include Single First-Order (SFO), Double First-Order in Parallel (DFOP), and Indeterminate Order Rate Equation (IORE) in accordance with NAFTA guidance (USEPA, 2012).
[2] Field dissipation half-life is for the parent compound only and ranges include values following each of five terrestrial applications and two aquatic applications to the field. Half-lives following the terrestrial application on bare and vegetated plots were 27-56 days and following the aquatic application on rice paddy were 11-24 days.

Table 3. Environmental Fate and Transport Properties for Major Degradate CGA 62826 (or NOA 409045)

Parameter	Value	Reference
Physical/Chemical Parameters		
CAS Name	N-(2,6-Dimethylphenyl)-N-(methoxyacetyl)-alanine.	
CAS Number	75596-99-5	MRID 47886102
Molecular Weight (g/mole)	265.31	EPI Suite (v4.11)
Molecular formula	$C_{14}H_{19}NO_4$	EPI Suite (v4.11)
Molecular Structure		
SMILES	COCC(=O)N(c1c(C)cccc1C)[C@H](C)C(=O)OC	
Mobility		
Freundlich organic carbon normalized soil-water partitioning coefficient (K_{FOC}) L/kg	B. Sandy Loam = 38, P. Sandy Loam = 31 G. Silt Loam = 43, V. Silt Loam = 45	MRID 47886103

Parameter		Value	Reference
Field Dissipation			
Degradate found in field dissipation (Detected leaching depth detection and time)	Unvegetated plot, -sandy loam soil	CA (0-6” depth at day 0)	MRID 40985403
	Tomato plot, -sandy loam soil	CA (0-6” depth at day 0)	MRID 40985404
	Bare plot, - loamy sand soil	CA (36-48” depth at day 270)	MRID 41765001
	Tobacco and bare soil plot	NC (24-36” depth at day 3 and 36-48” depth at day 212 in vegetated plot) (24-36” depth at day 3 in tobacco plot)	MRID 41765002
	Citrus plot	CA (36-48” depth at 9 months) (or 3 months after the third application at 3 month application interval)	MRID 41809301
Aquatic field dissipation	Rice paddy, -Alamo clay	CA: (3-6” depth at day 14)	MRID 42259803
	Rice paddy, -Falaya silt loam	CA: (6-9” depth at day 14)	MRID 42259804

3. Exposure Modeling

The available physical/chemical and environmental fate properties of metalaxyl/mefenoxam and its degradates of concern were used to calculate exposure model input parameters to estimate drinking water concentrations (EDWCs).

3.1 Residues of Concern

The residues of concern (ROC) or total toxic residues (TTRs) include the parent compounds metalaxyl/mefenoxam and two degradates, CGA-62826 and CGA 119857, that occurred at greater than 10% of the applied dose in laboratory fate studies based on the Metabolism Assessment Review Committee (MARC) decision memo (USEPA 2000, D269910). The degradate CGA 119857 was considered in previous dietary exposure and risk assessments by HED (USEPA 2010c, DP 371309) and was considered only in anaerobic aquatic metabolism half-life determinations in previous EFED drinking water assessments (USEPA 2007, DP324495 and USEPA 2010a, DP376655).

Unextracted residues formed >30% of the applied in three submitted aerobic soil metabolism studies (MRIDs 00104494, 47886102 and 47886104). Among them, one 120-d study reported up to 54.5% unextracted residues and 27.6% CGA-62826 (MRID 47886102). In a correspondence email dated on April 18, 2016, the registrant “*contends that extraction with a range of less polar solvents would not lead to greater extractability*”. However, an extraction method for better extraction efficiency was reported with three different extractants: 1) Acetonitrile:HOAc (8:2); 2) MeOH:H_2O (9:1) and 3) Dimethylformamide:1M HOAc (1:1) in a submitted 160-d aerobic soil metabolism study, in which the unextracted residues were only 4.3%, but the maximum CGA-62826 concentration reached up to 73.5% (MRID 43935301).

The ambiguous evidence shows a possible correlation between the decreasing of unextracted residue and increasing of CGA-62826, which leads to an assumption that the unextracted residue should be considered as a ROC until further clarification.

Table 4 provides environmental fate parameters for the metalaxyl/mefenoxam ROC. All half-lives were recalculated to include the ROC. As a result, the hydrolysis, aqueous photolysis and soil photolysis are all stable. The aerobic aquatic metabolism half-lives of the ROC are much longer than that of the parent compounds. Two different versions of the aerobic soil metabolism half-lives of the ROC were calculated with and without the incorporation of unextracted residues. This approach brackets high-end and low-end availability scenarios for residues undergoing aerobic soil metabolism. In addition, the soil mobility for parent compound (moderately mobile) and for CGA-62826 (very highly mobile) are considered for surface water and for groundwater exposure modeling scenarios, respectively.

Table 4. Environmental Fate Parameters of Metalaxyl/Mefenoxam Residues of Concern

Parameter	Value	Source
Persistence in Water		
Hydrolysis half-life (pH 5 and 7)	Stable	MRID 00104493
Aqueous photolysis half-life (25°C)	Stable	MRID 41156001
Anaerobic aquatic metabolism half-life (25°C)	1,456 d[1]	MRID 42259801
Aerobic aquatic metabolism half-life (25°C)	220 d (SFO)[2, 3] 660 d (DFOP)[2, 3] and 665 d (SFO)[2, 3]	MRID 42259802 MRID 47886101
Persistence in Soil		
Soil photolysis half-life (25 °C)	Stable	MRID 43883402
Aerobic soil metabolism half-life (20°C) (Excluding unextracted residues) Scenario 1	158 d (SFO) 751 d and 761 (SFO) 17.3 d (SFO) 86.8 d (SFO)	MRID 00104494 MRID 43935301 MRID 47886102 MRID 47886104
Aerobic soil metabolism half-life (20°C) (Including unextracted residues) Scenario 2	5,360 d (IORE)[2, 3] 917 and 923 d (SFO)[2, 3] 6,513 d (IORE)[2, 3] 2,450 d (IORE)[2, 3]	MRID 00104494 MRID 43935301 MRID 47886102 MRID 47886104
Mobility		
Freundlich organic carbon normalized soil-water partitioning coefficient (K_{FOC}), Parent	570, 20, 68, 86 and 1299 Mean = 409	MRID 43875309
Freundlich organic carbon normalized soil-water partitioning coefficient (K_{FOC}), CGA-62826	38, 31, 43 and 45 Mean = 39	MRID 47886103

[1] The DT_{50} was recalculated to include CGA-62826 (maximum of 48.07%) and CGA-119857 (maximum of 16.25%)
[2] The DT_{50} was recalculated to include CGA 62826
[3] IORE, DFOP and SFO are kinetics models used to generate the reported half-lives. The models were selected following the NAFTA kinetics guidance (USEPA, 2012).

3.2 Surface Water Modeling

A TTR approach was used to estimate aquatic exposure with the ROC half-lives (**Table 4**) and the chemical properties of metalaxyl/mefenoxam and its degradate CGA-62826 (**Tables 2 and 3**). The TTR approach is justified because there are two degradates of concern, for which a full environmental fate data profile is unavailable. Chemical property and environmental fate input values were chosen in accordance with current input parameter guidance (USEPA, 2009). The average Koc of the parent compound (Koc=409) is used because it is the most conservative soil mobility input for surface water environments. Based on analysis of the ROCs, the 90th percentile confidence bounds on the mean half-lives for aerobic soil metabolism, aerobic aquatic metabolism, and anaerobic aquatic metabolism were selected. The three times a single half-life value for anaerobic aquatic metabolism (1,456 d × 3 = 4,368 d) was used according to EFED model input guidance (USEPA 2009). The 90th percentile average aerobic soil metabolism half-life model input for ROCs including unextracted residues ($t_{1/2}$=5,000 d, input scenario 2) is about 8.2 times that for ROCs excluding unextracted residues ($t_{1/2}$=608 d, input scenario 1).

Surface water sourced drinking water exposure was estimated using the Tier II exposure model PWC (pesticide water calculator v1.5; December 8, 2015). The PWC is a graphical user interface that runs the Pesticide Root Zone Model (PRZM, v 5, November 15, 2006) and the Variable Volume Water Body Model (VVWM, 3/6/2014) (USEPA, 2006b). **Table 5** lists the chemical input parameters for PWC. Model input and output files are attached in **Appendix III**.

Table 5. PWC Chemical Input Parameters for Metalaxyl/Mefenoxam ROC [1]

Input Parameter	Value	Justification	Source
Organic carbon partition coefficient (K_{OC}) (L/kg_{OC})	409	Represents the mean K_{FOC} value of metalaxyl/mefenoxam Koc (n=5)	MRID 43875309
Aerobic aquatic metabolism half-life (days) [temp. (25 °C)]	790	Average = 515.7, SD=254.3, $t_{90,n-1}$ = 1.866, n=3 [2]	MRID 42259802 MRID 47886101
Anaerobic aquatic metabolism half-life (days) [temp. (25 °C)]	4,368	Represents a single soil half-life value times three [3]	MRID 42259801
Aqueous photolysis half-life (days) [latitude (40 °N)]	Stable	Represents the single value for the residues of concern (Included the CGA-62826)	MRID 41156001
Hydrolysis half-life at pH 7 (days)	Stable		MRID 00104493
Aerobic Soil Metabolism half-life that that excluded the unextracted residues (Days), [20°C] (input scenario 1)	608	Represents the upper 90% confidence bound on the mean of five half-lives for the ROC ((Excluding the unextracted residues) [3]	MRID 00104494 MRID 43935301 MRID 47886102 MRID 47886104
Aerobic soil metabolism half-life that included the unextracted residues (days), [20 °C] (input scenario 2)	5,000	Represents the upper 90% confidence bound on the mean of five half-lives for the ROC (Including the unextracted residues) [3]	MRID 00104494 MRID 43935301 MRID 47886102 MRID 47886104
Foliar half-life (days)	0	Default value in the absence of data	USEPA, 2009
Molecular mass (g/mol)	279.34	Metalaxyl/Mefenoxam molecular mass	MRID 47886102
Vapor pressure (torr)	2.2E-6	Study value for metalaxyl/mefenoxam	MRID 00079041

Input Parameter	Value	Justification	Source
Solubility in water (mg/L)	26,000	Study value for metalaxyl/mefenoxam	MRID 47886102

[1] Source data are in **Tables 2, 3 and 4.**
[2] Calculated 90th confidence bound on the mean of three half-life value; t_{input} = average $t_{1/2}$ + [$t_{90,n-1}$ * SD]/SQRT(n)
[3] EFED Input Guidance (USEPA. 2009).

The use pattern inputs for the PWC model are listed in **Table 6**. Modeled PWC scenarios were those applicable to the current use sites that resulted in the highest exposure. Because the application rates for mefenoxam are approximately half of that for metalaxyl, the modeling for mefenoxam were only for conservative aerobic half-life (input scenario 2). The maximum allowed application rates and numbers of applications per year on the labels were modeled. The initial application dates were selected within the scenario crop season and characterized by vulnerability to runoff. The default percent cropped area (PCA) of 100% was used because the fungicide can be used in both agricultural and non-agricultural settings (USEPA 2012).

Table 6. PWC Scenarios and Input Parameters Describing Maximum Patterns of Metalaxyl and Mefenoxam Uses on Representative Use Sites [1]

Use Site	PWC Scenario	Date of Initial App.	App. Rate in lbs a.i./A (kg a.i./ha)	App. per Year	App. Interval (days) [2]	CAM Input	Method [3]	Application Efficiency/ Spray Drift
Metalaxyl Uses								
Citrus	CA Citrus	April 1	4.1 (4.59)	3	90 [2]	2	A	0.95/0.135
	FL Citrus	April 1	4.1 (4.59)	3	90 [2]	2	A	0.95/0.135
Deciduous Fruit Trees, Stone Fruits and Tree Nuts	GA Peach	April 1	4.1 (4.59)	3	90 [2]	2	A	0.95/0.135
	MI Cherry	April 1	4.1 (4.59)	3	90 [2]	2	A	0.95/0.135
	NC Apple	April 1	4.1 (4.59)	3	90 [2]	2	A	0.95/0.135
	PA Apple	April 1	4.1 (4.59)	3	90 [2]	2	A	0.95/0.135
Citrus	FL Citrus	Oct. 1	10.4 (11.65)	1	-	2	SD	1/0
Mefenoxam Uses								
Citrus	CA Citrus	April 1	2 (2.24)	3	90 [2]	2	A	0.95/0.135
	FL Citrus	April 1	2 (2.24)	3	90 [2]	2	A	0.95/0.135
Deciduous Fruit Trees, Stone Fruits and Tree Nuts	GA Peach	April 1	2 (2.24)	3	90 [2]	2	G	0.95/0.135
	MI Cherry	April 1	2 (2.24)	3	90 [2]	2	G	0.95/0.135
	NC Apple	April 1	2 (2.24)	3	90 [2]	2	G	0.95/0.135
	PA Apple	April 1	2 (2.24)	3	90 [2]	2	G	0.95/0.135

[1] Source data are in **Appendix I**.
[2] 3-month application intervals (April 1, July 1 and October 1).
[3] A – Aerial spray, G – Ground spray and SD – Soil drench

Table 7 lists the EDWCs for metalaxyl/mefenoxam ROCs from surface water sources and the bolded fonts represent the maximum values. The data in parentheses represent the model input scenario 1 for the comparison of the aerobic soil half-life effect. The EDWCs for the two input scenarios are similar, indicating the longer aerobic soil half-lives do not substantially increase the EDWCs from surface water sources. EFED recommends the highest surface water EDWCs of **444 µg/L** for the 1 in 10 year daily peak concentration, **248 µg/L** for the 1 in 10 year annual

concentration, and **193 µg/L** for the 30 year annual average concentration. An example of a PWC modeling summary report for surface water analysis is shown in **Appendix III**

Table 7. Surface Water EDWCs for Metalaxyl/Mefenoxam ROC [1]

Scenario	Application Method	Application Rate (lbs ai/ha) and Date (mm/dd)	Concentration (µg/L)		
			1 in 10 yr Peak	1 in 10 yr Annual Average	30 year annual average
Metalaxyl Uses (PCA = 1)					
CA Citrus (w23155.dvf)	Aerial Spray	4.1 (4/1, 7/1 & 10/1)	260	236	**193**
FL Citrus (w12842.dvf)	Aerial Spray	4.1 (4/1,7/1 & 10/1)	**444** (440)[2]	147 (144)	99 (97)
GA Peach (w03813.dvf)	Aerial Spray	4.1 (4/1, 7/1 & 10/1)	181	107	78
MI Cherry (w14850.dvf)	Aerial Spray	4.1 (4/1, 7/1 & 10/1)	318 (310)	**248** (243)	180 (176)
NC Apple (w03812.dvf)	Aerial Spray	4.1 (4/1, 7/1 & 10/1)	207	120	92
PA Apple (w14751.dvf)	Aerial Spray	4.1 (4/1, 7/1 & 10/1)	272	153	126
CA Citrus (w23155.dvf)	Soil Drench	10.4 (7/1)	29	24	17
FL Citrus (w12842.dvf)	Soil Drench	10.4 (7/1)	308 (306)	79 (77)	53 (52)
Mefenoxam Uses (PCA = 1)					
CA Citrus (w23155.dvf)	Aerial Spray	2 (4/1, 7/1 & 10/1)	127	115	94
FL Citrus (w12842.dvf)	Aerial Spray	2 (4/1,7/1 & 10/1)	217	72	48
GA Peach (w03813.dvf)	Ground Spray	2 (4/1, 7/1 & 10/1)	78	40	26
MI Cherry (w14850.dvf)	Ground Spray	2 (4/1, 7/1 & 10/1)	139	106	72
NC Apple (w03812.dvf)	Ground Spray	2 (4/1, 7/1 & 10/1)	93	53	39
PA Apple (w14751.dvf)	Ground Spray	2(4/1, 7/1 & 10/1)	124	66	53

[1] Maximum values for each input scenario are in bold

[2] The data in parentheses represent the model input 1, which excludes the unextracted residues with the ROCs.

3.3 Groundwater Modeling

Groundwater-sourced drinking water exposure was estimated using the Tier II exposure model PWC (v1.5; December 8, 2015). The PWC incorporates the Tier I PRZM-GW model, which is a one-dimensional, finite-difference model that estimates the concentrations of pesticides in groundwater. It accounts for pesticide fate in the crop root zone by simulating pesticide soil transport and degradation after a pesticide is applied to an agricultural field. It permits the

assessment of multiple years of pesticide application (up to 100 years) on a single site. Six standard scenarios, each representing a different region known to be vulnerable to groundwater contamination, are available for the simulations. The output values represent pesticide concentrations in a vulnerable groundwater supply that is located directly beneath a rural agricultural field following many years of pesticide application. The breakthrough time (i.e., the number of days that it takes for the applied chemical to reach the aquifer) is simulated for 30 years (or for 100 years using extended weather files) to determine EDWCs.

The PWC input parameters for the ROCs, following the Input Parameter Guidance (USEPA, 2012*b*), are listed in **Table 8**. The average aerobic soil metabolism half-life of the ROC with the unextracted residues included ($t_{1/2}$=5,000d, input scenario 2) is about 8.2 times that of the ROC with the unextracted residues excluded ($t_{1/2}$=608d, input scenario 1). The surface soil half-life model input based on the TTR is the upper 90th percentile confidence bound on the mean of five ROC half-lives from studies conducted at 20°C. The organic carbon partition coefficient for the degradate CGA-62826 (Koc = 39 L/Kg) is used because it is more conservative than the Koc for the parent compound and represents the realistic situation of the degradate being the prominent residue in groundwater after breakthrough. Application inputs represented the use patterns of maximum exposure, which were three applications per year, each at 4.59 kg a.i./hectare, 90 days apart and a single application per year at 11.65 kg a.i./hectare. The selected initial date of application (April 1) is within the application season and may result in high-end concentrations in groundwater due to vulnerability to precipitation. Model input and output files are attached in **Appendix IV**.

Table 8: PWC-GW Input Parameters for Metalaxyl/Mefenoxam ROC [1]

Input Parameter	Value	Justification	Source
Metalaxyl Application Rate, lbs a.i./A (or kg a.i./H) [# of applications per year and interval]	4.1 (or 4.59) [3 and 90 days]	Maximum labeled single application rate with 3 applications at 90 days interval for deciduous fruit trees, stone fruits and tree nuts,	Reg. # 71532-5, 70506-289, 55146-109
Mefenoxam Application Rate, lbs a.i./A (or kg a.i./H) [# of applications per year and interval]	2 (2.24) [3 and 90 days]	Maximum labeled single application rate with 3 applications at 90 days interval for deciduous fruit trees, stone fruits and tree nuts,	Reg. # 100-1145, 100-1202, 100-798, 100-794,
Initial application date	Apr. 1	Within application season	(Selected)
Hydrolysis half-life (Days)	Stable		MRID 00104493
Aerobic Soil Metabolism half-life that that excluded the % unextracted residue (Days) [20°C] (input scenario 1)	608	Represents the upper 90% confidence bound on the mean of five half-lives for the ROC (Excluded the % unextracted residues)	MRID 00104494 MRID 43935301 MRID 47886102 MRID 47886104

Aerobic soil metabolism half-life that included the % unextracted residue (days), [20 °C] (input scenario 2)	5,000	Represents the upper 90% confidence bound on the mean of five half-lives for the ROC (Included the % unextracted residues)	MRID 00104494 MRID 43935301 MRID 47886102 MRID 47886104
Organic carbon partition coefficient (K_{OC}) (L/kg_{OC})	39	Represents the mean K_{FOC} value CGA 62826 Koc (n=4)	MRID 47886103
Henrys Constant (atm^3/mol)	$8.05E^{-10}$	Bond method	EPI Suite (v4.11)

[1] Source data are in **Tables 3, 5 and 6**.

The EDWCs for metalaxyl and mefenoxam ROCs from the groundwater sources based on six surrogate scenarios are listed in **Table 9**. The data in parentheses represent the model input scenario 1. The EDWCs from the input scenario 2 are much higher than that from the input scenario 1. The major increase of the EDWCs in groundwater source in the scenario 2 attributes to the incorporation of the unextracted residues into aerobic soil metabolism half-lives.

Table 9. Groundwater EDWCs for Metalaxyl and Mefenoxam ROC [A]

Crop/Scenario	Highest Daily Value µg/L	Post Breakthrough Average µg/L	Average Simulation Breakthrough Time Days
Metalaxyl at 4.1 lbs ai/acre (or 4.59 kg a.i./H), 3 aerial applications on 4/1, 7/1 & 10/1			
DELMARVA sweet corn Met File (13781.dvf)	4,604 (3,777) [B]	3,426 (2,897)	1,530
Florida Citrus - FL Met File (12842.dvf)	4,021 (3,490)	3,171 (2,776)	1,105
Florida - potato Met File (13889.dvf)	2,575 (1,576)	2,003 (1,356)	1,163
GA - PEANUTS Met File (w93805.dvf)	1,630 (1,350)	1,328 (1,133)	1,729
NC Cotton Met File (13722.dvf)	**6,512** **(4,922)**	**4,413** **(3,485)**	2,315
Wisconsin Corn Met File (14920.dvf)	4,256 (3,804)	3,711 (3,344)	2,813
Metalaxyl at 10.4 lbs ai/acre (or 11.65 kg a.i./H), 1 soil drench application on 7/1			
DELMARVA sweet corn Met File (13781.dvf)	2,488	2,272	5,871
Florida Citrus - FL Met File (12842.dvf)	2,705	2,455	4,818
Florida - potato Met File (13889.dvf)	1,014	896	7,944
GA - PEANUTS Met File (w93805.dvf)	988	812	7,435
NC Cotton Met File (13722.dvf)	**3,760**	**3,443**	5,741
Wisconsin Corn Met File (14920.dvf)	2,948	2,536	7,630
Mefenoxam at 2 lbs ai/acre (or 2.24 kg a.i./H), 3 aerial applications on 4/1, 7/1 & 10/1			

DELMARVA sweet corn Met File (13781.dvf)	2,247 (1,843) [B]	1,672 (1,414)	1,530
Florida Citrus - FL Met File (12842.dvf)	1,963 (1,703)	1,548 (1,355)	1,105
Florida - potato Met File (13889.dvf)	1,257 (768)	978 (662)	1,163
GA - PEANUTS Met File (w93805.dvf)	796 (659)	648 (553)	1,729
NC Cotton Met File (13722.dvf)	**3,179** (2,402)	**2,153** (1,701)	2,315
Wisconsin Corn Met File (14920.dvf)	2,077 (1,858)	1,811 (1,632)	2,813

[A] Maximum values for each input scenario are in bold

[B] The data in parentheses represent the model input scenario 1, which excludes unextracted residues with the ROCs.

EFED recommends EDWCs of **6,512 µg/L** for acute exposure and **4,413 µg/L** for chronic exposure, which supersede the previous groundwater concentration of 1.7 ppb from SCI-GROW. This recommendation is based on the maximum annual application rate at 12.3 lb/A (metalaxyl) and includes the unextracted residues into the aerobic soil half-life calculation.

The data in **Table 9** also presented several modeling scenarios. Clarification of the uncertainty for the unextracted residues may potentially reduce the EDWCs. If the unextracted residues are shown to be irreversibly bound to soil and removed from the ROCs, EFED would recommend the EDWCs are not expected to exceed **4,922 µg/L** for acute exposure and **3,485 µg/L** for chronic exposure.

EFED has explored a different currently labeled application technique other than the aerial spray. If metalaxyl is applied as a soil drench at the maximum application rate at 10.4 lb/A, the EDWCs including unextracted residues are **3,760 µg/L** for acute exposure and **3,443 µg/L** for chronic exposure. Excluding unextracted residues would result in lower EDWCs.

In addition, reduction of the application rate may also reduce the EDWCs. The maximum annual application rate for aerial spray of mefenoxam at 6 lb/A, which is about half of that for metalaxyl, was modeled. Resulting EDWCs including unextracted residues are **3,179 µg/L** for acute exposure and **2,153 µg/L** for chronic exposure.

Finally, the possibility of groundwater well setback distances for the reduction of the acute EDWCs were calculated with the following equation:

$\frac{C}{C_0} = \exp\left(-\frac{L}{v}k\right)$	C = concentration at well C_0= concentration at point of application L = well setback distance [feet] v = lateral groundwater velocity [feet/day] k = degradation rate in aquifer [day^{-1}]

The distances needed for a groundwater well setback to reduce the EDWCs from 6,512 ppb (acute) to 3,500 ppb was 4,500 ft (0.85 miles) and to 2,500 ppb was about 7,000 ft (1.33 miles) (Fig. 2).

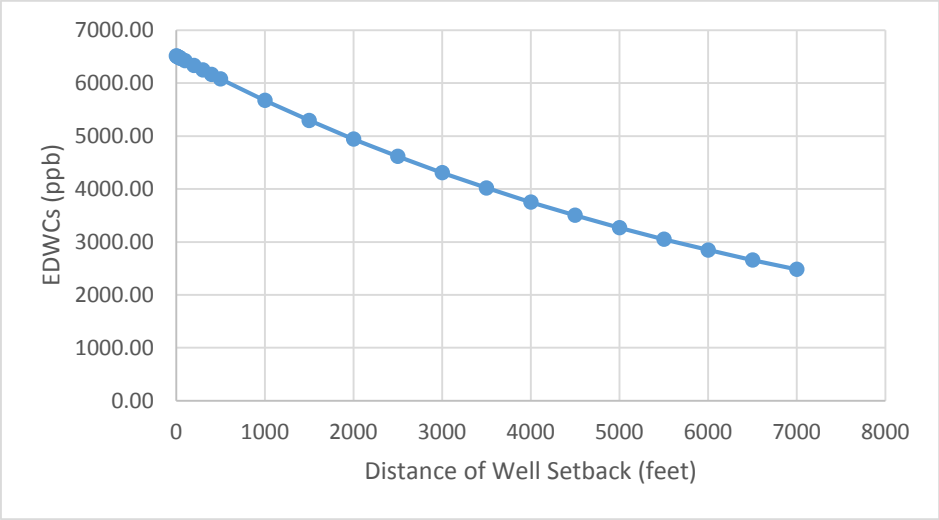


Fig. 1. Groundwater EDWCs (ppb) with the distances of well setback

An example of PWC modeling for groundwater analysis is shown in **Appendix IV**.

4. Monitoring Data

Metalaxyl monitoring data were found in the NAWQA water quality portal (WQP) (Accessed on April 29, 2016, http://waterqualitydata.us/), which integrates public available water quality data from the USGS National Water Information System (NWIS), the EPA STOrage and RETrieval (STORET) Data Warehouse, and the USDA ARS Sustaining The Earth's Watersheds Agricultural Research Database System (STEWARDS). The maximum parent metalaxyl concentration was **46.4 µg/L** in New York surface water and **3.79 µg/L** in Washington groundwater below 12.5 feet. The parent residues were found in deep groundwater (90 feet) in California (0.02 µg/L), and 480 feet in New Hampshire (0.01 µg/L). In a registrant-performed prospective groundwater study in the mid-1980s, the maximum metalaxyl concentration was 3 µg/L in drinking water wells, which were located near a field treated up to 1.0 lb ai/A (USEPA 2007, DP324495). No monitoring data for mefenoxam or degradate CGA 62826 were found in the WQP database (Accessed April 29, 2016).

Metalaxyl/mefenoxam monitoring data were not found in the California Department of Pesticide Regulation (CDPR) surface water database (Accessed on April 29, 2016, http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm). Metalaxyl was not detected in 27 groundwater samples taken in 2014 in Fresno County, California (http://www.cdpr.ca.gov/docs/emon/grndwtr/wellinv/wirmain.htm, 2015 Report).

Maximum concentrations of metalaxyl in the monitoring data (up to 3.79 µg/L) are less than those from groundwater modeling (4,400-6,500 µg/L) for a variety of reasons, including the lack of targeted monitoring analyses, lack of analysis for degradates of concern, potentially less usage in practice than the modeled use patterns, and uncertainty in the environmental fate data used in modeling, including uncertainty in the stability of metalaxyl/mefenoxam to hydrolysis and uncertainty in the availability of the unextracted residues.

5. Uncertainties, Assumptions, and Limitations

The use and usage information are incomplete. Many labels have application characteristics are not specified (NS) such as the maximum number of applications per year, the maximum annual rate and the minimum retreatment intervals. To the extent that use exceeds assumptions in this assessment, the DWA may under-predict exposure.

The drinking water assessment employs a bridging strategy for the environmental fate and transport properties of mefenoxam and metalaxyl. There is no consideration of enantioselective degradation or transport processes for the individual isomers of metalaxyl. Therefore, the environmental behavior of individual isomers is assumed to be similar with no impact on total metalaxyl/mefenoxam residue concentrations in groundwater or surface water at a similar application rate.

Metalaxyl/mefenoxam residues of concern were considered in modeling. This approach assumes degradation products, CGA-62826 and CGA 119857, have equivalent toxicity to metalaxyl/mefenoxam. This approach is conservative because the kinetics of the residues of concern reflect the combined residues of concern and their mobility is determined by the most mobile representative compound.

There is major uncertainty associated with the substantial amount of unextracted residues (up to 53.8%) in the aerobic soil degradation studies. These unextracted residues were included and excluded from the half-life calculations to provide two sets of the EDWCs in this assessment. The Agency recommends conducting an aerobic soil metabolism study that uses polar and nonpolar extraction solvents with a variety of dielectric constants or the similar extraction solvents as MRID 43935301 to reduce uncertainty in the availability of the unextracted residues.

Groundwater exposure estimates are sensitive to the hydrolysis rate. There is uncertainty in the extrapolation of the results of a 30-d study to estimate compound stability for 30 years. An extended-duration, more accurate hydrolysis study may help to refine the groundwater EDWCs.

6. References

USEPA. 1994. Metalaxyl - RED Candidate - Environmental Fate and Ground Water Assessment. DP197035. 18pp.

USEPA. 1999. Section 18 Request for Use of Mefenoxam (Chemical # 113502, DP Barcodes D254867 and D260764) as a Canola Seed Treatment in North Dakota (with Tier 1 Drinking Water Numbers). DPs254867 and 260764. 5pp.

USEPA. 2000. Mefenoxam. Metabolism Assessment Review Committee (MARC) Decision Document for Meeting Held on 10/24/00. Chemical #113502. DP Barcode: D269910. Case #290692. Submission #S553336. 5pp.

USEPA. 2007. Drinking Water Assessment for Mefenoxam. DP324495. 27pp.

USEPA. 2009. EFED Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides. Version 2.1, October 22, 2009

USEPA. 2010a. Drinking Water Assessment for Mefenoxam (Metalaxyl-M) for Snap Beans, Caneberries (crop group 13-07A), Spinach, Bushberries (crop group 13-07B), Bulb Onions (subgroup 3-07A), Green Onions (subgroup 3-07B). DP376655. 24pp.

USEPA. 2010b. Registration Review–Preliminary Problem Formulation for Environmental Fate, Ecological Risk, and Endangered Species for metalaxyl (PC Code 113501) and mefenoxam (aka metalaxyl-M, PC Code 113502). D368463. 55pp.

USEPA. 2010c. Mefenoxam Chronic Aggregate Dietary (Food and Drinking Water) Exposure and Risk Assessment for the Section 3 Registration Action on Snap Bean (Succulent) and the Caneberry Subgroup 13-07A, Expanded Uses on the Bulb Onion Subgroup 3-07A, the Green Onion Subgroup 3-07B, and the Bushberry Subgroup 13-07B, and Amended Use on Spinach. D371309. 39 pp

USEPA. 2012a. Approval of PRZM-GW for Use in Drinking Water Exposure Assessment. EFED Memo 12/11/2012. Pp. 1.

USEPA. 2012b. Guidance for PRZM-GW in Drinking Water Exposure Assessment. October 15, 2012. Pp. 20

USEPA. 2012c. Guidance on Development and Use of Percent Cropped Area and Percent Turf Area Adjustment Factors in Drinking Water Exposure Assessments: 2012 Update. March 16, 2012 Memo. 50pp.

USEPA. 2013. Guidance on Modeling Offsite Deposition of Pesticides via Spray Drift for Ecological and Drinking Water Assessments. December 10, 2013 Memo. 40pp.

USEPA. 2014. Surface Water Concentration Calculator User Manual. OPP 734F14001, July 1, 2014.

USEPA. 2015a. Updated Screening Level Usage Analysis Report for Metalaxyl, PC Code # 113501, (Reporting Years 2004-2013). OPP Biological and Economic Analysis Division (BEAD). June 4, 2015. 3 pp.

USEPA. 2015b. Updated Screening Level Usage Report for Mefenoxam, PC Code # 113502, (Reporting Years 2004-2013). OPP Biological and Economic Analysis Division (BEAD). June 4, 2015. 3 pp.

6.1 Submitted Environmental Fate and Product Chemistry Studies

MRID	Citation Reference
104493	Burkhard, N. (1976) Hydrolysis of CGA-48988 under Laboratory Con- ditions: Project Report 26/76. (Unpublished study received Jul 13, 1978 under 100-EX-62; prepared by Ciba-Geigy, Ltd., Switz., submitted by Ciba-Geigy Corp., Greensboro, NC; CDL: 234438-C)
41156001	Martinson, J. (1988) Photodegradation of Aqueous Solutions of Metalaxyl Exposed to Natural Sunlight: SLS Report No. 88-09-2799. Unpublished study prepared by Springborn Life Sciences, Inc. 32 p.
43883402	Sparrow, K. (1995) Photodegradation of (carbon 14)-CGA-329351 on Soil Under Artificial Light: Lab Project Number: ABR-95094: 151-95. Unpublished study prepared by Ciba Crop Protection. 199 p.
43935301	Fathulla, R. (1996) Aerobic Soil Metabolism of (Carbon 14)-CGA-329351 in a Sandy Loam Soil: (Amended Final Report): Lab Project Number: HWI 6117-280: 58-95: TX-94-0317. Unpublished study prepared by Hazleton Wisconsin, Inc. 363 p.
43935302	Fathulla, R. (1996) Column Leaching Characteristics of Aged (Carbon 14)-CGA-329351 in Four Soil Types: Lab Project Number: 61-95: CHW 6117-284: 6117-284. Unpublished study prepared by Corning Hazleton Inc. 720 p
42259801	Vithala, R. (1992) Anaerobic Aquatic Metabolism of ?carbon 14|-Metalaxyl: Amended Final Report: Lab Project Number: 005/001/007/89. Unpublished study prepared by Center for Hazardous Materials Research. 229 p.
47886102	Mondel, M. (2003) Mefenoxam: Degradation of CGA329351 in Soil "Pappelacker": Final Report. Project Number: SYN04, T002133/08. Unpublished study prepared by Service Center for the Rural Region Rheinpfalz. 48 p.
47886103	Dorn, R. (2002) Mefenoxam: Adsorption/Desorption of CGA329351 in Four Soils: Final Report. Project Number: NOV08, T002136/08. Unpublished study prepared by State Academy and Research Institute for Agriculture, Viniculture and Horticulture. 83 p.

47886104 Hein, W. (2003) Mefenoxam: Degradation of CGA329351 in Soil "Birkenheide": Final Report. Project Number: NOV07, T002135/08. Unpublished study prepared by State Academy and Research Institute for Agriculture, Viniculture and Horticulture. 51 p.

47886101 Mogenroth, 1994. ^{14}C-CGA48988 (metalaxyl) – degradation and metabolism in aquatic systems. Unpublished study performed by RCC Umweltchemie AG, Itingen/BL, Switzerland; and sponsored and submitted by Syngenta Crop Protection, Inc., Greensboro, North Carolina. Report No.: 341076. Task No.: T005133-08. 118p

42259802 Vithala, R. (1991) Aerobic Aquatic Metabolism of ?carbon 14|-Metalaxyl: Lab Project Number: 005/002/008/89. Unpublished study prepared by Center for Hazardous Materials Research. 130 p.

40985403 Jones, P. (1988) Field Dissipation Study on Ridomil 5G on Bare Ground: Madera, California: Laboratory Study No. 87031. Unpublished study prepared by Pan-Agricultural Laboratories, Inc. 208 p.

40985404 Jones, P. (1989) Field Dissipation Study on Ridomil 5G Tomatoes Madera, California: Laboratory Study No. 87031. Unpublished study prepared by Pan-Agricultural Laboratories, Inc. 209 p.

41765001 LeRoy, R. (1991) Terrestrial Field Dissipation of Ridomil 2E on Bare Ground: Lab Project Number: EF-88-04B: 80202. Unpublished Study prepared by Pan-Agricultural Laboratories, Inc. & ChemAlysis Inc. 234 p.

41765002 Braxton, S.; Bird, R. (1991) Ridomil 2E-Field Dissipation-Tobacco and Bare Soil-North Carolina: Lab Project Number: 23TBBS. Unpublished study prepared by Environmental Technologies Institute & ChemAlysis Laboratories. 491 p.

41809301 Leroy, R. (1990) Metalaxyl: Terrestrial Field Dissipation of Ridomil 2E on Citrus: Final Report: Lab Project Number: EF-88-04A: 80201. Unpublished study prepared by Pan-Agricultural Labs, Inc. and ChemAlysis, Inc. 254 p.

42259803 Leech, G.; Wiepke, T. (1992) Aquatic Dissipation of Metalaxyl (Ridomil 2E) in a California Rice Paddy: Lab Project Number: EF-90-326: 31/90-CGA.1. Unpublished study prepared by Pan-Agricultural Laboratories, Inc. and Twin City Testing Corp. 272 p.

42259804 Biever, R. (1992) Ridomil 2E (metalaxyl): An Aquatic Dissipation Study for Water Seeded Rice in Memphis, Tennessee: Final Report: Lab Project Number: 91-11-4013: 1781-0490-6242-330. Unpublished study prepared by Springborn Laboratories, Inc. and Agricenter International, Inc. 173 p.

47886101 Morgenroth, U. (1994) (Carbon 14)-CGA48988 (Metalaxyl) - Degradation and Metabolism in Aquatic Systems: Final Report. Project Number: 341076, T005133/08. Unpublished study prepared by RCC Umweltchemie Ag. 118 p

100468 Ladd, S.; Wilson, W. (1979) Accumulation and Elimination of 14C-residues by Bluegill Sunfish ... Exposed to 0-14C-CGA-48988: Report #BW-78-10-328. (Unpublished study received Apr 26, 1979 under 100-600; prepared by EG & G, Bionomics; submitted by Ciba-Geigy Corp., Greensboro, NC; CDL:238232-E)

APPENDIX I

Table A1. Summary of Application Rates for Registered Uses of Mefenoxam

Uses	Application Method[1]	Maximum rate / single application (lbs a.i./A)	Maximum Number of applications / year (Crop Cycle)	Maximum Annual (Seasonal) Rate (lbs ai/A)	Minimum Retreatment Interval (days)
Barley	ST	.00005971 lbs/ lbs seed	NS[2]	NS[2]	NS[2]
Sweet Corn	ST	.00007464 lbs/ lb seed	NS	NS	NS
Cotton	ST	.00008658 lbs / lb seed	NS	NS	NS
Legume Vegetables	ST	.00003713 lbs/ lb seed	NS	NS	NS
Soybeans	ST	.00015038 lbs/ lb seed	NS	NS	NS
Triticale	ST	.00005971/lb ai seed	NS	NS	NS
Wheat	ST	.00005971/lb ai seed	NS	NS	NS
Alfalfa	A,G,B,Ch	.25056563	NS	NS	NS
Apple	A, G, B, Ch	4.00905	NS	NS	NS
Artichoke	A, G,	NS	NS	NS	NS
Asparagus	A,G, Ch	.5013725	NS	NS	NS
Avocado	Ch, Soil Drench	2.00549	(3)[3]	6	90
Basil	G	0.50655	NS	NS	NS
Beans (succulent, snap)	G, CH	0.1	2	(0.2)[3]	7
Blueberry	A, G	1.804941	NS	(3.6)	NS
Broccoli, Chinese Broccoli	A,G	0.06249375	NS	0.5	14
Brussels Sprouts	A, G	.06249375	NS	(0.5)	14
Bulb Vegetables	Furrow	.06552773	(1)	(1)	NS
Bush Berries	A,G	1.804	(2)	(3.6)	NS
Cabbage, Chinese Cabbage	A,G	.06249375	NS	(0.5)	14
Caneberries	G, Ch	0.1	(2)	(0.2)	7
Carrots	A, G, Ch	1	NS	1	NS
Cauliflower	A, G	.06249375	NS	(0.5)	14
Citrus	G, Ch	3	3	(6)	90
Clover	A, G, Ch	0.25056563	NS	NS	NS
Cole Crops	A, B	1	NS	1	NS
CONIFERS (PLANTATIONS/NURSERIES)	B, Ch	2.5	NS	NS	NS
Cotton	G	0.12220955	NS	NS	NS
Cranberry	B, Ch	0.875	(3)	(2.65)	NS
Cucumber	A, G	0.13540313	NS	(0.5)	10
Cucurbit Vegetables	A, G, Ch	1	NS	(1)	NS

Uses	Application Method[1]	Maximum rate / single application (lbs a.i./A)	Maximum Number of applications / year (Crop Cycle)	Maximum Annual (Seasonal) Rate (lbs ai/A)	Minimum Retreatment Interval (days)
DECIDUOUS FRUIT TREES (UNSPECIFIED)	G, Ch	4	NS	6.0786	90
FRUITING VEGETABLES	A, G	0.5	NS	1.5	NS
Garlic	A, G	0.10	NS	(0.5)	7
Ginseng	G	0.375	NS	1.5	30
Grapes	G, Ch	1.8	NS	NS	NS
GRASS FORAGE/FODDER/HAY	G, A, Ch	.5013725	NS	NS	NS
Herbs	G, B	1	NS	(2)	NS
Hops	Drench	0.25	NS	0.25	NS
Kiwi	Drench	0.35	(5)	1.7539	30
Leafy Vegetables	A, G, B	1	NS	1	NS
Leek	A, G, B	0.104	NS	0.3	NS
Legume Vegetables	A, G, C	0.5	NS	0.5	NS
Lettuce	A, G, C	1	(1)	NS	NS
Melons	A, G, B	0.135	NS	0.5	10
Onion (bulb and Green)	A, G, B	0.5	NS	NS	7
ORCHARDS (UNSPECIFIED)	G	2	NS	6	60
Turf	G	.68053136	(3)	NS	7
Ornamentals (Unspecified) Greenhouse (indoor)	Ch, G, Drench	1.6-3.40	NS	20.03	21-70
Peanuts	A, G	1.8	NS	NS	NS
Pepper	G, Ch	0.1	4	1.5	NS
Pineapple	Dip	0.50	NS	NS	NS
Potato	A,G	0.1	NS	(0.188)	14
Pumpkin	A,G	0.135	NS	(0.5)	10
Radish	A,G	0.1	(4)	NS	14
Raspberry	Band Treatment-Granular	1.81	(2)	NS	NS
Root and Tuber Vegetables	A,G	1.00	NS	NS	NS
Shallot	A,G	0.104	NS	(0.3)	NS
Soybeans	A,G	0.627	NS	NS	NS
Spinach	G	1	NS	1	NS
Squash	A,G	0.135	NS	(0.5)	10
Stone Fruits	G	2	3	(6)	60
Strawberry	G, C	0.5	(3)	(1.5)	NS
Subtropical fruit	G, C	1.5	(2)	(3)	NS
Sugar Beet	A,G	1	NS	NS	NS
Tobacco	G	1.5	1	1.5	NS

Uses	Application Method[1]	Maximum rate / single application (lbs a.i./A)	Maximum Number of applications / year (Crop Cycle)	Maximum Annual (Seasonal) Rate (lbs ai/A)	Minimum Retreatment Interval (days)
Tomato	A,G,C	1	NS	(1.5)	NS
Tree Nuts	G	2	3	6	60

[1]A=Aerial, G-Ground, B= Broadcast, Ch=Chemigation, ST= Seed Treatment,
[2]NS --not specified. A label clarification for the maximum annual rate and minimum retreatment interval is needed to reduce this uncertainty.
[3] Numbers in parenthesis are the maximum number of application or rate per seasonal (crop cycle). A label clarification for the annual rate is needed to reduce this uncertainty

Table A2. Summary of Application Rates for Registered Uses of Metalaxyl

Crop	Application Method[1]	Single Maximum Application Rate (lbs ai/A)	Max # of applications	Maximum Annual (Seasonal) Rate (lbs ai/A)	Minimum Retreatment Interval (days)
Ornamental Grasses	ST	0.00002 lb/lb seed		NS[2]	NS[2]
Flax	ST	0.00004 lb/lb seed		NS	NS
Cucumber, Mustard, Okra, Clary Sage, Beets (Unspecified)	ST	0.0001 lb/lb seed		NS	NS
Onions (Green), Brassica (Cole) Leafy Vegetables	ST	0.0002 lb/lb seed		NS	NS
Barley, Beans, Beans, Dried-Type, Beans, Succulent (Lima), Beans, Succulent (Snap), Beets (Greens),Brassica (Head And Stem) Vegetables, Buckwheat, Canola\Rape, Carrot (Including Tops), Cereal Grains, Clover, Cole Crops, Clover, Cole Crops, Corn, (Pop, Sweet, Silage, Filed), Cotton, Cowpea, Blackeyed Pea, Sitao Cowpea, Cucurbit Vegetables, Dill, Fruiting Vegetables, Garbanzos (Including Chick Peas), Golf Course Turf, Grass Forage/Fodder/Hay, Leafy Vegetables, Lentils, Lespedeza, Lupine(Grain), Oats , Nongrass Forage/Fodder/Straw/Hay, Oats, Onion, Ornamental And/Or Shade Trees, Ornamental Lawns And Turf, Peanuts, Peas, Residential Lawns, Rice, Root And Tuber Vegetables, Rye, Small Grains, Small Seeded Legumes, Soybeans, Sugar Beet, Trefoil, Triticale, Vetch, Wheat	ST	0.0003 lb/lb seed		NS	NS

Crop	Application Method[1]	Single Maximum Application Rate (lbs ai/A)	Max # of applications	Maximum Annual (Seasonal) Rate (lbs ai/A)	Minimum Retreatment Interval (days)
Corn, Sweet, Golf Course Turf, Ornamental Lawns And Turf, Peas, Residential Lawns, Sunflower,	ST	0.0006 lb/lb seed		NS	NS
Peas	ST	0.0008 lb/lb seed		NS	NS
Corn (Unspecified), Sorghum	ST	0.0011 lb/lb seed		NS	NS
Proso Millet	ST	0.0014 lb/lb seed		NS	NS
Raspberry (Black, Red)	BT	0.0003 lb/Linear foot		NS	NS
Alfalfa	A, G, B	0.508		NS	NS
Almond, Apple, Blueberry	A,G, B, BT, D	4.1		NS[2]	60
Asparagus	A/G B	1		NS	NS
Avocado	G, SID	0.92 (lb/tree)		12.2	90
Christmas Tree Plantations	Ch, BT	5		NS	NS
Citrus	**A,G.B**	**4.1**	**3 (estimated)**	**12.3 (estimated)**	**90**
Citrus	A, G, B, BT, D	4	3 (estimated)	12	90
Citrus	**G, D**	**10.4**		**NS (assume 1)**	**90**
Citrus	Ch, BT, B	5.3		NS	**NS**
Clover	G, B	0.51		NS	NS
Cole Crops	G, B	2		2	NS
Commercial/Industrial Lawns	B, Ch	2.7		NS	14
Conifers (Plantations/Nurseries)	G, B	5.5		12	NS
Cranberry	G, B	1.8	3	(5.34)[3]	NS
Cucurbit Vegetables	G, B, BT	2.0		2.0	NS
Deciduous Fruit Trees (Unspecified)	**A, G, B, BT**	**4.2**	**3 (estimated)**	**12.3**	**90**
Eggplant	A, G, B, BT	2		3	17
Forest Trees (Softwoods, Conifers)	G, B, BT, Ch	5		NS	NS
Fruiting Vegetables	A, G, B, BT, ShT	1		3.04	17
Ginseng	D	1.5		NS	NS
Golf Course Turf	G B, Ch	2.7	3 application of 1.4 lbs ai/A	NS	17
Grass Forage/Fodder/Hay	A,G, B,	1		NS	NS
Hops	G, B, BT	0.5	3	NS	NS
Leafy Vegetables	G, B, BT	2	1 (estimated)	(2)	NS
Legume Vegetables	G, B, BT	1		NS	NS
Lettuce	G, B, BT	2	1 (estimated)	(2)	NS
Onion	G, B, BT	1		NS	NS

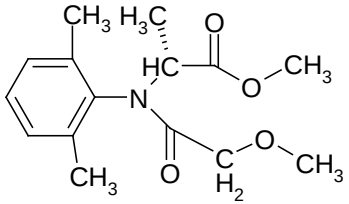
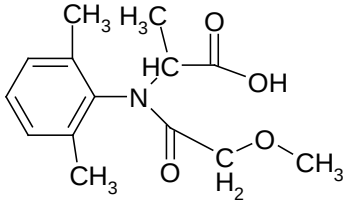
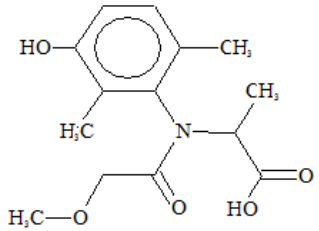
Crop	Application Method[1]	Single Maximum Application Rate (lbs ai/A)	Max # of applications	Maximum Annual (Seasonal) Rate (lbs ai/A)	Minimum Retreatment Interval (days)
Ornamental And/Or Shade Trees	G, B, BT, D	6.8		NS	70
Ornamental Herbaceous Plants	G, B, Ch, BT, D	3.4		NS	42
Ornamental Lawns And Turf	G, B, Ch	2.7	3 applications of 1.4 lbs ai/cc	NS	14
Ornamental Nonflowering Plants	SM, D and MT	1.7		NS	NS
Ornamental Sod Farm (Turf)	G B, Ch	2.7	3 applications of 1.4 lbs ai/cc	NS	14
Ornamental Woody Shrubs And Vines	SM/MT	3.4		NS	NS
Ornamentals (Unspecified)	Soil D	3.5		NS	60
Papaya	SST	3.6	2	NS	14
Peanuts	Ch	1		NS	NS
Pepper	A,G, B, BT	2		3	17
Pineapple	DT	1		NS	NS
Potato, White/Irish (Or Unspecified)	B, SI	2		NS	NS
Recreation Area Lawns	B, Ch	2.7	3 applications of 1.4 lbs ai/A)	NS	14
Residential Lawns	B, Ch	2.7		NS	14
Root And Tuber Vegetables	B, BT	2		(2)	NS
Soybeans (Unspecified)	A, G, B	1.3		NS	NS
Spinach	G, B, BT	2		(2.8)	21
Stone Fruits	A, G, B, BT	**4.1**	**3**	**12.3 (estimated)**	**60**
Strawberry	G, B, BT	1		3	30
Sugar Beet	G, B, BT	2		NS	NS
Tobacco	G, B, BT	3		NS	NS
Tomato	A, G, B, BT	2		(3)	NS
Tree Nuts	**A, G, B, BT**	**4.1**		**12.2**	**90**
Trefoil	A, G, B,	0.5		NS	NS
Walnut (English/Black)	A, G, B, BT	4.1		NS	60

[1]A=Aerial, B= Broadcast, BT=Band Treatment, Ch=Chemigation, D=Drench, G-Ground, DT= Dip Treatment, MT= Media Treatment, ShT=Shanking Treatment, SI= Soil Incorporated, SID= soil injection dripline, SM=Soil Mix, SST= Surface Soil Treatment, ST= Seed Treatment,

[2]NS --not specified. A label clarification for the maximum annual rate and minimum retreatment interval is needed to reduce this uncertainty.

[3] Numbers in parenthesis are the seasonal rate. A label clarification for the annual rate is needed to reduce this uncertainty

APPENDIX II Metalaxyl/Mefenoxam and Its Major Environmental Degradates

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	Ref. (MRID)	Maximum %AR (day)[A]	Final %AR (study length)
PARENT						
Metalaxyl / Mefenoxam **SMILES:** COCC(=O)N(c1c(C)cccc1C)[C@H](C)C(=O)OC	Methyl N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-D-alaninate **CAS No.:** 70630-17-0 **Formula:** $C_{15}H_{21}NO_4$ **MW:** 279.34 g/mole					
MAJOR TRANSFORMATION PRODUCTS						
CGA 62826 (or NOA 409045) **SMILES:** COCC(=O)N(c1c(C)cccc1C)[C@H](C)C(=O)OC	N-(2,6-Dimethylphenyl)-N-(methoxyacetyl)-alanine **Formula:** $C_{14}H_{19}NO_4$ **MW:** 265.31 g/mol		Aq photolysis	41156001	5.7% (14 d)	5.7% (14 d)
			Aerobic aquatic	42259802	20.6% (30 d)	20.6% (30 d)
				47886101	74.1% (181 d) 87.8% (112 d)	71.5% (240 d) 76.3% (240 d)
			Anaerobic aquatic	42259801	85.53% (265 d)	48.07% (385 d)
			Aerobic Soil	00104494 43935301 47886102 47886104	53.6% (66 d) 78% (130 d) 27.6% (14 d) 38.6% (63 d)	25% (360 d) 72% (160 d) 0.3% (119 d) 33.8% (119 d)
			Terr dissipation [C]	40985403 40985404 41765001 41765002 41809301	25% (30 d) 57% (30 d) 22% (1 d) 10% (9 d) 66% (28 d)	5% (336 d) 3% (336 d) <1% (548 d) <2% (534 d) <1% (548 d)
			Aq dissipation [D]	42259803 42259804	23% (7 d) 7.7% (1 d)	n.d [B] (259 d) n.d [B] (367 d)
CGA 119857 (in anaerobic conditions) **SMILES:** CC1=C(C(=C(O)C=C1)C)N([C@H](C)C(=O)O)C(=O)COC	N-(3_hydroxy-2, 6-dimethylphenyl)-N-(methoxyacetyl)-L-alanine **Formula:** $C_{14}H_{19}NO_5$ **MW:** 281.31 g/mol		Anaerobic aquatic	42259801	16.25% (385 d)	16.25% (385 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	Ref. (MRID)	Maximum %AR (day)[A]	Final %AR (study length)
Unextracted Residues	Unknown	-	Aerobic Soil	00104494 43935301-1 43935301-2 47886102 47886104	38.3% (360 d) 4.3% (160 d) 4.7% (130 d) 53.8% (43 d) 32.4% (119)	38.3% (360 d) 4.3% (160 d) 1.3% (160 d) 50.9% (119 d) 32.4% (119 d)

[A] Bolded values indicate a major degradate was formed or that a degradate is of toxicological significance

[B] n.d. means “not detected”.

[C] Terrestrial field study percentages represent the ratio of degradate concentration to the maximum parent concentration, both in the top layer of soil.

[D] Aquatic field study percentages represent the ratio of degradate concentration to the maximum parent concentration, both in the top layer of sediment .

APPENDIX III

Summary of Water Modeling of Metalaxyl and the USEPA Standard Reservoir

Estimated Environmental Concentrations for Metalaxyl are presented in Table 1 for the USEPA standard reservoir with the MICherriesSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Pesticide Water Calculator (PWC), Version 1.52. Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 1% of Metalaxyl applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (55% of the total transport), followed by spray drift (40.3%) and erosion (4.76%).

In the water body, pesticide dissipates with an effective water column half-life of 287.4 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is washout (effective average half-life = 331.4 days) followed by metabolism (2167.6 days) and volatilization (2.265683E+07 days).

In the benthic region, pesticide dissipation is negligible (3995.0 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 3995 days). The vast majority of the pesticide in the benthic region (97.79%) is sorbed to sediment rather than in the pore water.

Table 1. Estimated Environmental Concentrations (ppb) for Metalaxyl.

Peak (1-in-10 yr)	312.
4-day Avg (1-in-10 yr)	310.
21-day Avg (1-in-10 yr)	301.
60-day Avg (1-in-10 yr)	286.
365-day Avg (1-in-10 yr)	243.
Entire Simulation Mean	177.

Table 2. Summary of Model Inputs for Metalaxyl.

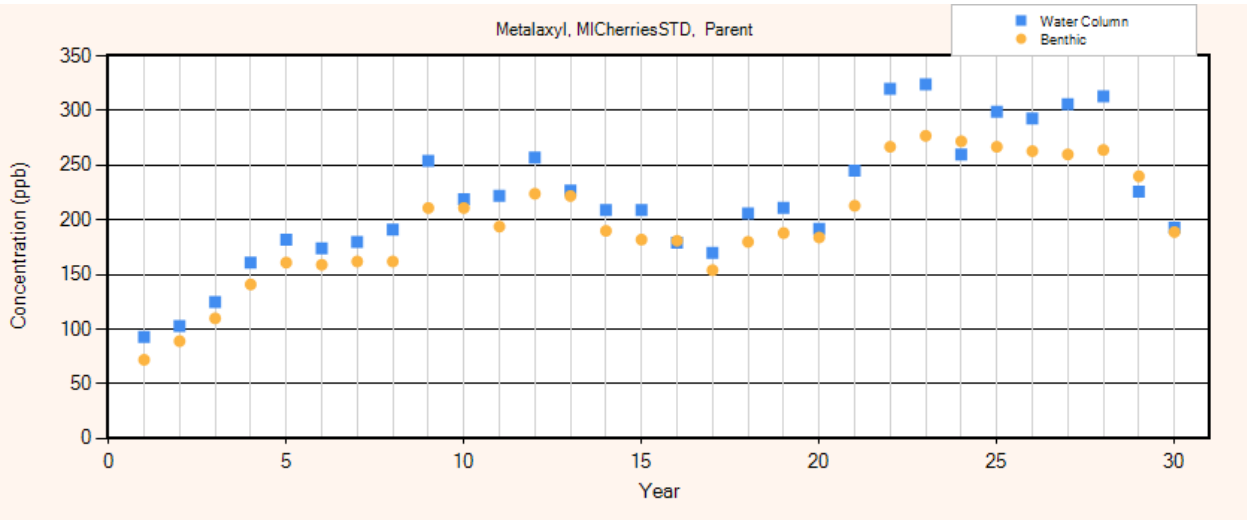
Scenario	MICherriesSTD
Cropped Area Fraction	1.0
Koc (ml/g)	409
Water Half-Life (days) @ 25 °C	790
Benthic Half-Life (days) @ 25 °C	1456
Photolysis Half-Life (days) @ 40 °Lat	0

Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 20 °C	3233
Foliar Half-Life (days)	
Molecular Weight	279.34
Vapor Pressure (torr)	2.2e-6
Solubility (mg/l)	26000
Henry's Constant	8.05E-10

Table 3. Application Schedule for Metalaxyl.

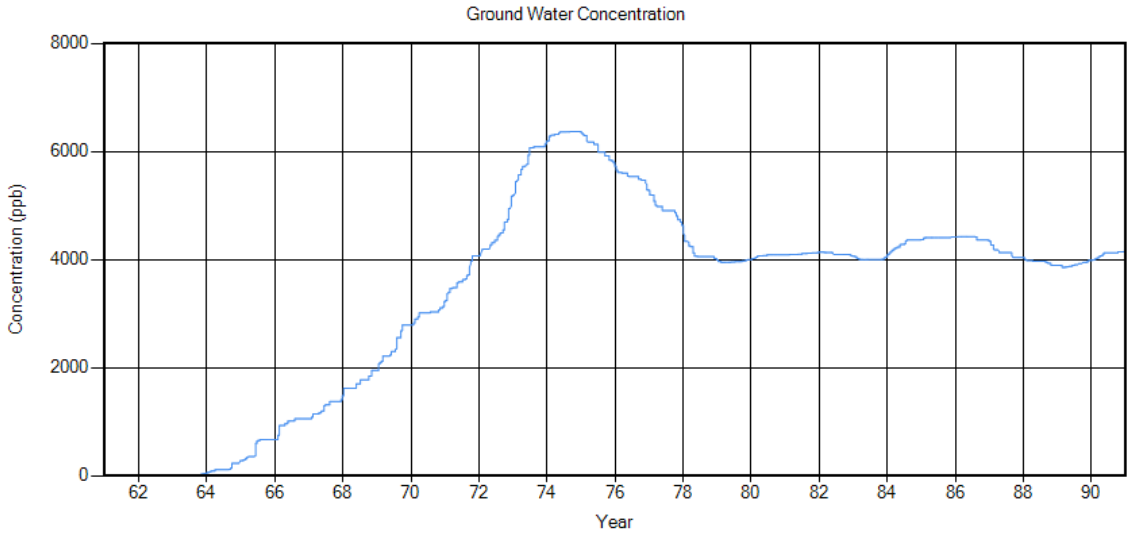
Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
4/1	Above Crop (Foliar)	4.59	0.95	0.135
7/1	Above Crop (Foliar)	4.59	0.95	0.135
10/1	Above Crop (Foliar)	4.59	0.95	0.135

Figure 1. Yearly Peak Concentrations



APPENDIX IV

Groundwater Analysis for Metalaxyl in North Carolina Cotton, Met File (13722.Dvf)



APPENDIX V Aquatic Model Calculations

Model Input & Output Files


Metalaxyl-GW-7.zip


Metalaxyl-SW-7.zip

Total Residue of Concern Environmental Fate Calculations


113502_DT50_Sum_5-12.xlsx